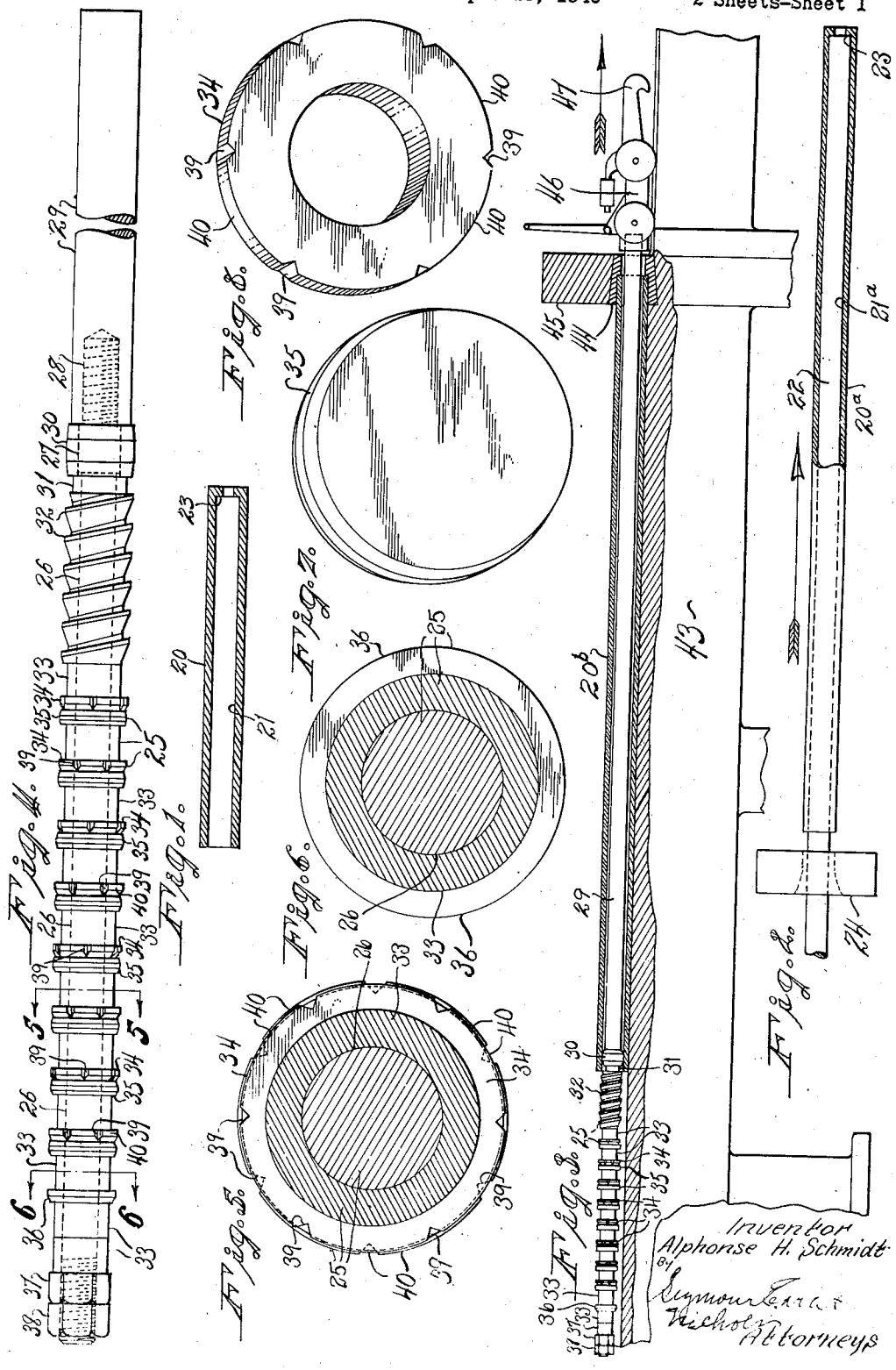
Aug. 11, 1942. A. H. SCHMIDT 2,292,900

BROACH

Filed Sept. 16, 1940 2 Sheets-Sheet 1



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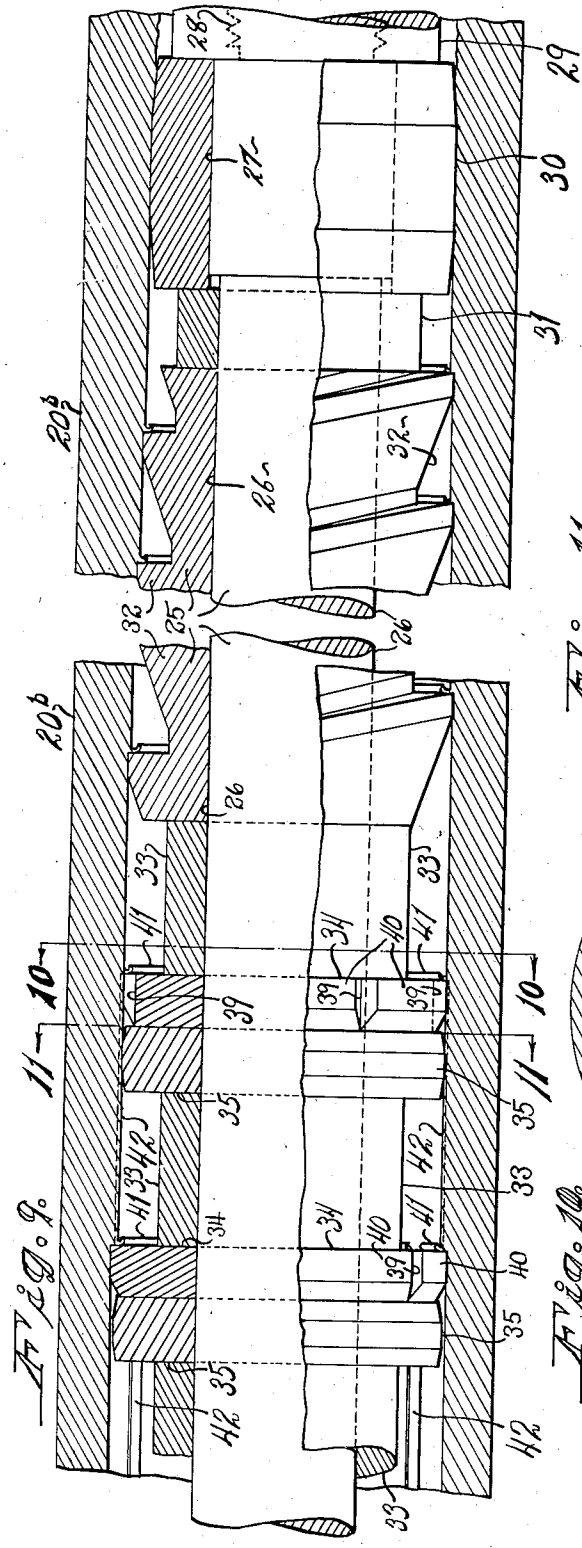


Fig. 9.

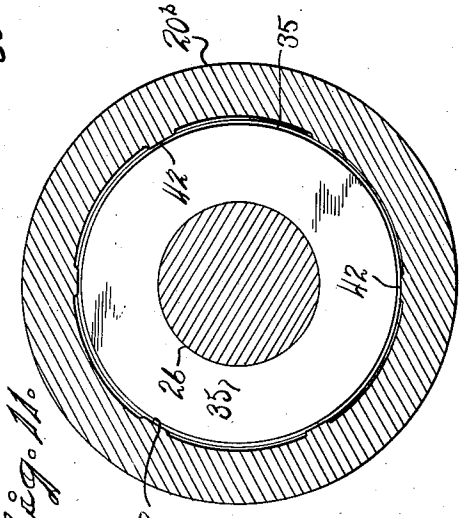


Fig. 11.

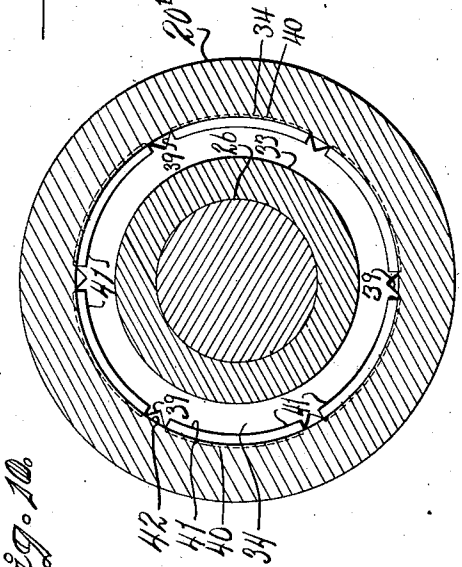


Fig. 10.

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5 Claims. (Cl. 29—95.1)

This invention relates to improvements in apparatus for removing imperfections from the interior of tubular articles, and more particularly from the interior of tubes.

In connection with the manufacture of tubes by drawing, etc., it is common to first cast a blank in tubular form. After this blank is removed from the mold it is found to have its interior surface oxidized, with dirt inclusions, surface defects such as blow holes, gas pockets, etc., which imperfections interfere with producing a perfect tube by the subsequent drawing operations or the like. While these defects have been heretofore removed in various ways, I have devised an improved method and apparatus for removing these defects more quickly and at lower cost than the methods heretofore employed.

An object of this invention is to provide an improved apparatus for removing imperfections from the interior of tubes.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure, this invention includes all features in the said disclosure which are novel over the prior art.

In the accompanying drawings forming part of the present disclosure, in which one way of carrying out the invention is shown for illustrative purposes:

Fig. 1 is a longitudinal central sectional view of a cast tube blank;

Fig. 2 is a longitudinal central sectional view of the blank shown in Fig. 1, mounted on a mandrel and after the blank has been passed through a reducing-die;

Fig. 3 is a fragmental side elevation partly in section illustrating the drawn tube-blank after removal from the mandrel in Fig. 2 and having its right end cut off, mounted on a draw bench ready to have the broaching operation performed to remove the imperfections from the interior of the tube;

Fig. 4 is an enlarged side elevation of the broach shown in Fig. 3;

Fig. 5 is a sectional view on line 5—5 of Fig. 4;

Fig. 6 is a sectional view on line 6—6 of Fig. 4;

Fig. 7 is a perspective view of one of the guide-members;

Fig. 8 is a perspective view of one of the notched ring-shape cutter-members;

Fig. 9 is an enlarged central-longitudinal sectional view through a portion of a tube with a portion of the broaching tool shown therein, and performing its operations on the interior of the tube;

Fig. 10 is a sectional view on line 10—10 of Fig. 9; and

Fig. 11 is a sectional view on line 11—11 of Fig. 9.

In the description and claims, the various parts and steps are identified by specific names for convenience, but they are intended to be as generic in their application as the prior art will permit.

Referring to the drawings showing the particular form of the invention chosen for illustration, 20 is a tubular blank, which may be a casting, of any suitable metal such, for example, as copper or a copper-base alloy, which may, for example, be brass, which is to be subsequently wrought into a tube or the like. The diameter of the interior surface portion 21 of the blank 20 is of a size to permit the blank to freely slide onto the mandrel 22 (Fig. 2), the blank 20 having an annular flange 23 to engage against the end of the mandrel 22 to hold the blank in proper position on the end of the mandrel while the blank is being forced through a reducing-die 24, the blank being shown in elongated form 20*a* in Fig. 2 after it has been forced through the die 24. The end portion of the mandrel 22 which is engaged by the blank 20*a* preferably tapers slightly to a smaller diameter at its end so that the elongated blank 20*a* can be readily forced off from the end of the mandrel 22. This taper may, for example, be about .003'' per foot. After removal from the mandrel 22, the end portion of the blank 20*a* containing the flange 23 is cut off to produce a tube blank 20*b* shown in Fig. 3 in position to have the broaching operation performed thereon.

In order to illustrate the nature of the steps in proceeding from a cast blank such as the blank 20, it may be mentioned that one such blank which has been used has a length of about four feet over all, an outside diameter of about four inches and a wall thickness of the main portion of the tubular blank of about three-quarters of an inch. After this cast blank 20 has been given a drastic reduction by passing it through the die 24 illustrated in Fig. 2, it becomes the elongated blank 20*a* having a length of about seven feet, the outside diameter being reduced to about three and three-eighths inches and the wall thickness being reduced to about one-half inch. When the blank 20 is cast, the inner annular surface 21 of the blank forms an oxidized area containing dirt, surface defects such as blow holes, gas pockets, etc. When this cast blank 20 is subjected to the reducing operation shown in Fig. 2, many of these defects are forced closer to

the inner surface into a thinner area about the mandrel, thus condensing the imperfections of the interior of the tube in a smaller thickness within less distance from the interior surface 21 of the tube, thus facilitating the later removal of these imperfections with a minimum waste of metal. Inasmuch as the inner surface 21*a* of the blank 20*a* is in close engagement with the tapered surface of the mandrel 22, this inner surface 21*a* will have a taper corresponding to the taper of the mandrel 22.

In order to eliminate or remove the imperfections from the interior of the tubular blank 20*b*, a tool 25 such as illustrated in Figs. 3 to 11 may be employed. Before the blank 20*b* is submitted to the broaching operation, it is given an annealing heat treatment, with the result that the blank frequently has warped or bent portions resulting from the heat treatment, but by employing a sectional or composite broach which has cutter and guide members mounted on an arbor which is separate or independent from the cutter and guide members as hereinafter described, the broaching tool is flexible and is able to spring transversely to accommodate itself to the crooked hole in the crooked tube, and thus permits of uniformly cutting or removing the inner surface portion of the tube with minimum loss of metal, whereas a broach which had the arbor, cutters and guides all formed as a single, integral member would be too rigid and unyielding to permit of this perfection of result without first straightening the tube. And some annealed tubes have small kinks that would not be eliminated even by giving the tube a mechanical straightening treatment.

The particular tool 25 illustrated in the drawings includes an arbor 26 having an enlarged annular shoulder-portion 27 from which extends a reduced screw-threaded portion 28 screw-threadedly engaging a draw-bar 29 which engages against the shoulder-portion 27. Mounted on the shoulder-portion 27 is a sizing or expanding ring 30, against which is engaged a spacer-ring 31, against which, in turn, is a helical broaching-cutter 32, against the left or rear end of which is engaged another spacer-ring 33. Against the spacer-ring 33 is a notched ring-shape broaching-cutter 34, against the rear of which engages a ring-shape guide-member or disk 35. In the particular broach shown, there are a total of eight of these groups of parts 33, 34 and 35, to the rear of the last of which is another spacer-ring 33, against the rear of which is a ring-shape finishing-cutter 36, to the rear of which are two spacers 33, the rearmost of which is engaged by a nut 37 threaded on the rear end of the arbor 26 which nut 37 serves to firmly lock all of the parts on the arbor 26 against the draw-bar 29, the nut 37 being locked against loosening by a lock-nut 38. While each guide-disk 35 is shown as separate from its adjacent preceding notched cutter 34, it could be made integral therewith.

The arbor 26 and the draw-bar 29 can be of cold-rolled steel or any other suitable metal. The sizing or expanding ring 30, the helical cutter 32, the notched cutters 34, guide-disks 35 and the finishing-cutter 36 will preferably be of suitable tool steel or equivalent, and the various spacing-rings will also preferably be of tool steel.

The outside diameter of the sizing-ring 30 will be of a diameter sufficient to expand the tapered inner surface of the tubular blank 20*b* to a true cylindrical size preferably of about the same diameter as the forward or leading end of the helical cutter 32. The diameter of each successive pitch or convolution of the helix or spiral of the helical cutter 32 will preferably be a small amount larger than the diameter of the preceding convolution. Each spacer-ring 33 provides chip-clearance in front of the following ring-cutter 34 (or 36).

The cutting diameter of the first or foremost notched ring-cutter 34 will preferably be a small amount larger than the diameter of the last convolution of the helical cutter 32, and the cutting-diameter of each succeeding ring-cutter 34 will be a small amount larger than the corresponding diameter of each preceding ring-cutter 34, the diameter of the rearmost finishing ring-cutter 36 being a small amount larger than the diameter of the rearmost of the notched ring-cutters 34.

Inasmuch as the helical cutter 32 cuts a shaving in the form of a spiral, it is not necessary to provide this cutter with notches to break up the chips. But in the case of the ring-cutters 34, these are each provided with notches 39, each of which notches 39 spaces apart successive cutter portions 40 annularly about a cutter 34, thus breaking up what would be a circular chip into separated shavings or chips 41 (Fig. 10). The notches 39 of each cutter 34 are preferably not aligned axially with the notches of each adjacent ring-cutter 34. The last ring-cutter 36 has no notches and therefore produces a true cylindrical finish on the interior of the tube.

Assuming the cutting diameter of each notched cutter 34 to be about .002'' larger than the cutting diameter of the preceding notched cutter 34, each notch 39 of a notched cutter 34 will leave a longitudinal land or rib 42, and the next rearward or following notched cutter 34 will cut the hole to a diameter about .002'' larger than the diameter left by the preceding notched cutter and at the same time will completely remove the lands 42 left by the preceding notched cutter. The depth of cut between lands is thus about .001'', and the depth of cut in removing a land is about .002''.

The first guide-disk 35 immediately behind and adjacent the first or foremost notched ring-cutter 34 is of a diameter to ride along the lands left by the notches of the first notched cutter 34, thus limiting and gauging the depth of cut and preventing side-drift or uneven cutting action or gouging of the first or leading notched ring-cutter 34, so as to ensure a uniform depth of cut of about .001''. As the next rearward or second notched ring-cutter 34 has its notches non-aligned with the notches of the first notched cutter 34, the second notched cutter 34 cuts away the lands 42 left by the notches of the first notched cutter 34 and enlarges the main portion of the diameter of the tube about .002'' while the notches of the second notched cutter 34 leaves lands of the diameter cut by the first notched cutter 34, the second rearward guide-disk 35 riding along these lands 42 left by the notches of the immediately adjacent and preceding or second notched cutter 34, thus strictly guiding or gauging the depth of cut of its adjacent preceding cutter so that a uniform depth of cut is made all around the inside of the tube. This mode of action of the notched cutters 34 and their adjacent guide-disks 35 is carried out by each of the notched cutters and guide-disks illustrated on the broaching-tool 25, the lands left by

the rearmost notched cutter **34** being removed by the cylindrical unnotched finishing cutter **36**. Not only does each guide-disk **35** limit and gauge the depth of cut of the adjacent preceding ring-cutter, but it also does this for the following ring-cutter to an effective degree, and especially when the following ring-cutter is just entering the tube being broached.

Thus it will be seen that when the tubular blank **20***b* is placed on the draw-bench **43** with its forward end in the tube-support die **44** carried by the die-head **45**, and with the broaching-tool **25** having its draw-bar **29** extending through the tubular blank **20***b* and connected to the draw-bench tongs **46**, that when the hook **47** of the draw-bench tongs is engaged with the traveling drawing-means (not shown) of the draw-bench, the broach **25** will be drawn through the tubular blank **20***b*, with the result that the sizing-ring or expander **30** will expand or properly size the slightly tapered tube to a truly cylindrical proper size so that the following broaching-cutters **32**, **34** and **36** cut portions of the inner surface of the tube away in the manner that has heretofore been set forth, to thus effectively and speedily remove the imperfections from the interior of the tube in one travel of the broaching cutter through the tube, after which the tube blank can be subjected to further drawing or other suitable operations. While it is preferred to use the helical cutter **32** as the leading cutter, it could be replaced by other cutter-means such as the notched ring-cutters **34**.

While it has been found advantageous to remove the imperfections from the tube blank at the particular stage of operations heretofore described, it will be appreciated that it is contemplated that the imperfections may be removed at any stage of manufacture of a tube desired.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

I claim:

1. A broach comprising: sizing-means constructed and arranged to expand the surface portion of the interior of a tube to be broached; helical cutter-means rearward of said sizing-means; and a plurality of ring cutter-members rearward of said helical cutter-means and at different longitudinal locations on the broach and of progressively larger diameter toward the rear of the broach.

2. A broach comprising: a plurality of cutter-members at different longitudinal locations on the broach and of progressively larger diameter toward the rear of the broach; and guide-members between said cutter-members each said guide-member being of less diameter than the cutting diameter of the immediately-preceding cutter-member and having a bearing-area constructed and adapted to limit the depth of cut of such immediately-preceding cutter-member.

3. A broach comprising: a plurality of cutter-members at different longitudinal locations on the broach and of progressively larger diameter toward the rear of the broach, said cutter-members each having cutter-portions spaced apart by notches, and notches of successive cutter-members being at different circumferential locations, and the rearmost of each two successive notched cutter-members having a guide-member adjacent and behind it, the diameter of each said guide-member being substantially equal to the cutting-diameter of the foremost of each such two successive notched cutter-members so as to ride along lands left by notches of the rearmost of each such two successive cutter-members.

4. A broach comprising: an arbor; a plurality of cutter-members separate from the arbor and from each other and mounted on the arbor at different longitudinal locations of the arbor, said cutter-members being of progressively larger diameter toward the rear of the broach; and guide-members between said cutter-members each said guide-member being of less diameter than the cutting diameter of the immediately-preceding cutter-member and having a bearing-area constructed and adapted to limit the depth of cut of such immediately-preceding cutter-member.

5. A broach comprising: an arbor; a plurality of cutter-members separate from the arbor and from each other and mounted on the arbor at different longitudinal locations of the arbor, said cutter-members being of progressively larger diameter toward the rear of the broach, said cutter-members each having cutter-portions spaced apart by notches, and notches of successive cutter-members being at different circumferential locations, and the rearmost of each two successive notched cutter-members having a guide-member adjacent and behind it, the diameter of each said guide-member being substantially equal to the cutting-diameter of the foremost of each such two successive notched cutter-members so as to ride along lands left by notches of the rearmost of each such two successive cutter-members.

ALPHONSE H. SCHMIDT.